

A formula for verifying cracked shafts

BENTLY'S CORNER

By
Don Bently

In the Spring/Summer 1981 ORBIT, we identified a breakthrough in detecting cracked shafts. We found that a shaft which has asymmetric stiffness due to a lateral crack is cross coupled.

We showed how the behavior of a shaft with a lateral crack may be observed by loading the shaft with a weight and noting the vertical and horizontal deflection as the shaft is rotated.

This same test may be performed on a machine by installing a trial weight of a fixed amount at a fixed radius at one place every 30 to 45 degrees successively around the rotor and by testing the response of the rotor system for each angular location of the trial weights.

The effect of a lateral crack in a shaft of the High Spot, leading or lagging the Heavy Spot at static or low speed was noted. The simple equation for this effect is:

$$\tan(A + B) = \frac{K_{\text{normal}}}{K_{\text{weak}}} \tan B$$

where K_{normal} = normal spring rate of the shaft

K_{weak} = spring rate of shaft deflected at the crack

A = deflection of the shaft with respect to the imbalance

B = angle of the imbalance with respect to the crack as shown in Figure 1:

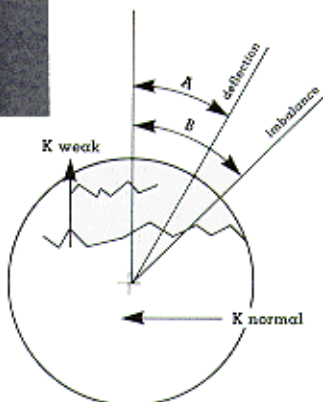


FIGURE 1

Figure 2 shows this equation graphed for typical values of cracked shaft stiffness ratios. This angle is leading or lagging, depending on the direction of rotation and, of course, continues for the next 90 degrees, unless the crack closes (a "breathing" crack). If the crack closes, the stiffness ratio is unity half of each turn, and there is no cross couple action for that 90 degree sector. The ratio of the shaft stiffness is determined experimentally by observing the minimum and maximum amplitude readings for the resultant deflection for any imbalance weight.

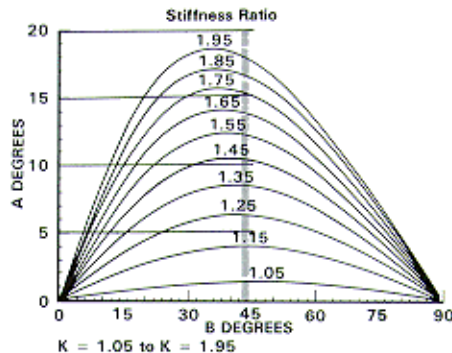


FIGURE 2

Donald E. Bently, President of Bently Nevada, will be a featured lecturer at the Rotor Dynamics Engineering and Applied Vibration Engineering concurrent seminars in Daytona Beach, Florida, February 15-18, 1982. Sponsored by Union College, Schenectady, New York.

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